Clinical Use of CT and MR Scans in Psychiatric Patients

Leo E. Hollister, Nashaat Boutros
Harris Country Psychiatric Center, Department of Psychiatry, University of Texas Medical School, Houston, Texas
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During a three-year period, 337 CT or MR scans were ordered for psychiatric patients in a teaching hospital. Scans were normal in 185 instances, equivocal in 34, and abnormal in 118 instances. When a history of neurologic disorder and/or the presence of abnormal neurologic/organic mental signs was positive, scans were abnormal in 74% of cases; when these indicators were negative, scans were normal in 72% of cases. In all, only 4 new diagnoses were made. Two patients, both with markedly abnormal neurological findings, were shown to have brain tumors, which changed their management. Two others showed abnormalities which would have been missed, both of which were of no clinical consequence. The following are suggested as sound indications for ordering CT or MR brain imaging among psychiatric patients: 1) positive history of head injury, stroke or other neurologic disease, as well as suspected Alzheimer disease or multi-infarct dementia; 2) presence of abnormal neurologic signs or organic mental signs, such as confusion or cognitive decline; and, 3) a first psychotic break or personality change after the age of 50 years.

Keywords: computerized tomography (CT), magnetic resonance imaging (MRI), clinical indications, neurological abnormalities, psychiatric patients

It is well established that some disorders of the brain may present initially or solely with mental signs or symptoms (Raskin 1956; Klotz 1957; Oxman 1979). The possibility that some of these may be reversible has led to the employment of brain imaging in psychiatric practice. A number of studies in recent years has addressed the issue of the proper use of brain imaging in psychiatry (Owens et al 1980; Larsen et al 1982; Evans 1982; Holt et al 1982; Roberts and Lishman 1984; Beresford et al 1986). These studies varied between advocating imaging scans as a reasonable screening procedure for all patients, risking very high cost as well as very low yield, while other studies restricted the recommendation to scan only those patients with clear focal neurological abnormalities on examination, accepting the risk of missing a rare early diagnosis.

Because of such wide divergence of opinion about the proper utilization of brain imaging scans, the present survey was done to determine the nature and frequency of the clinical indications for their order, to review the results of the scans, and to assess how such scans affected the management of the patients. We were aware that manifold factors might determine the decision to order brain imaging; consequently, no attempt was made to restrict in any way the clinician's order as such an attempt would seriously bias the natural experience.

Address reprint requests to: Leo E. Hollister, M.D., HCPC, PO Box 20249, Houston, Texas, U.S.A., 77225.

MATERIAL REVIEWED

Three hundred thirty-seven CT or MR scans ordered during a three-year period at the Harris County Psychiatric Center (HCPC) were reviewed. All orders for scans were approved by junior faculty attending psychiatrists. All scans were done with the most recently available equipment in an academic department of radiology and were read by qualified neuroradiologists. Usually the neuroradiologist was able to indicate decisively whether the scan was within normal limits or was abnormal.

In reviewing records of patients subjected to brain imaging, data were collected about certain specified parameters. Demographic data about patients were noted and

an attempt was made to identify the indication for the brain scan, either from the current working diagnosis or from the material on the request for the scan. Entries about the neurological and psychiatric examinations of patients were reviewed specifically for abnormal neurologic signs or symptoms suggesting an organic mental disorder. EEG reports were tabulated. An estimate of the consequences of having the scan was based on the follow-up management of patients.

RESULTS

Types of Brain Scans and Interpretations

Although, as shown in Table 1, MR scans were used more frequently than CT scans, this preference changed over time. At the beginning of the three-year period CT scans were ordered more often, but by the end of that period MR scans were ordered almost exclusively. Scans were read as normal in 55%, abnormal in 35% and equivocal in 10% of the cases. The main difference between the two scanning techniques was the greater frequency of equivocal scans using the MR technique. Most of these involved reports of few (sometimes only one), small signals from the periventricular white matter, so-called unidentified bright objects. The assumption has been that these may represent small vascular lesions but the clinical significance of such signals remains uncertain.

Clinical Indications for Ordering Brain Scans

As shown in Table 2, "organicity" was the most frequent indication. Scans were most often ordered to rule out some presumed structural lesion, as clinical signs or symptoms suggestive of such a lesion were scanty. An organic mental symptom or sign or an abnormal neurologic sign was present in only 19 of the 138 patients with this indication. Only 27 had borderline abnormal EEG patterns, such as slowing or occasional sharp waves, which have been attributed to the effects of drug therapy or which possibly may be normal variants. The clinical diagnosis of these patients was usually schizophrenia, mania or schizoaffective disorder. The majority of abnormalities reported among the 39 patients showing them were varying degrees of atrophy, mild and generalized, as have been repeatedly observed among patients with such disorders.

None of the other indications approached such frequency. The highest yield of abnormal scans was among patients clinically diagnosed as having Alzheimer disease or multi-infarct dementia, those with clinical evidence of an old stroke or history of head injury, and a miscellaneous group composed largely of patients with other diagnosed neurological diseases (17), cancer (5), HIV positivity (4), pituitary disorder (5) and CNS syphilis (2). Virtually all abnormal findings were confirmative of what was already known clinically, either by history or physical examination.

Predictive Value of Neurologic History/Signs and EEG

Table 3 shows the relationship between clinical and EEG findings and results of brain scans. When either a history of neurologic disorder or neurologic/organic mental signs was absent, brain scans were normal in 75% of cases (ignoring equivocal results). When both were positive, scans

Table 1
Types of Brain Scans Ordered in 337 Psychiatric Patients

	Normal	Equivocal	Abnormal	Total
Type of Scan	N=185	N=34	N=11	N=337
CT	78	4	58	140
MR	107	30	60	197

Table 2
Clinical Indications for 337 Brain Imaging Scans

	Normal N=185	Equivocal N=34	Abnormal N=118	Total N=337
Organicity, associated or contributing to functional disorder	83	16	39	138
History of seizures	33	1	10	44
Alzheimer, multi-infarct dementia	3	5	15	23
History/residua of stroke	0	0	8	8
History/residua of head injury	8	0	15	23
Mental retardation	7	2	5	14
Alcohol/substance abuse	13	0	1	14
Abnormal EEG	14	1	4	19
Miscellaneous	10	1	21	32
Not stated	14	8	0	22

Table 3
Contribution of History of Neurological Disorder, Presence of Abnormal Neurologic Sign or Abnormal EEG to Prediction of Abnormal Brain Imaging Scan

	Normal N=185	Equivocal N=34	Abnormal N=118	Total N=337
History neurological disorder and/or positive neurologic/mental signs	23	8	65	96
Neither present	162	26	53	241
EEG abnormal	38	11	43	92
EEG normal	116	21	59	196
EEG not obtained	31	2	16	49

were abnormal in 74% of cases (Chi square 63.6, 1 df, $p < .001$). A normal EEG was associated with a normal brain scan in only 66% of cases, and an abnormal EEG was associated with an abnormal scan in only 47% of cases (Chi square 8.6, 1 df, $p < .001$). Thus, the EEG alone was less effective than clinical history and neurologic examination as a predictor of abnormal scans.

The combined use of neurologic history/examination and EEG is shown in Table 4. When both the history/exam and EEG were normal, the scan was normal 79% of the time. When both were abnormal, the scan was abnormal 92% of the time (Chi square 45.2, 1 df, $p < .001$).

When the neurologic history/exam was abnormal but the EEG was normal, scans were abnormal 65% of the time. When the EEG was abnormal but the neurologic history/exam was normal, scans were abnormal only 37% of the time. A positive neurologic history/exam was more predictive of an abnormal scan than the EEG.

Diagnoses from Brain Scanning

Evaluation of brain imaging data resulted in only 4 new diagnoses. Two patients with clinical evidence of neurological abnormalities of uncertain cause were definitively diagnosed (Table 5). One patient, a 67-year-old woman, experienced recent cognitive decline with new episodes of blind rage. The electroencephalogram showed a slow wave abnormality in the left temporal area. CT scan revealed a large tumor in the mid-cranial fossa. She was referred to surgery and a sphenoid wing meningioma was removed.

Table 4
Prediction of Imaging Result Based on Combining Neurologic History/Exam and EEG

	Normal Scan N=152	Abnormal Scan N=92	Total Scans N=244
Neuro exam normal EEG normal	99	27	126
Neuro exam abnormal EEG abnormal	2	22	24
Neuro exam abnormal EEG normal	11	20	31
Neuro exam normal EEG abnormal	40	23	63

Table 5
Diagnostic Yield of 337 Brain Imaging Scans in 337 Psychiatric Patients

	Normal N=185	Equivocal N=34	Abnormal N=118	Total N=337
New diagnosis	0	0	4	4
Confirm clinical impression	0	2	29	31
Atrophy of uncertain cause	0	7	59	66
Incidental miscellaneous	0	18	26	44
No diagnosis made	185	7	0	192

Subsequently, her behavior improved markedly but not her memory, which had very likely been impaired by alcohol abuse. Another patient was a 53-year-old woman who had no prior mental symptoms but had recently shown some changes in behavior. Her right pupil was non-reactive and she showed frontal release signs bilaterally. Dysmetria, worse on the right, was also noted. She refused an EEG. CT scan showed a 4 x 4 cm suprasellar mass suggestive of a craniopharyngioma. She was transferred to another hospital for further treatment. These two patients were the only ones in which the clinical management was changed as a result of imaging. Two other patients had abnormalities not clinically evident that would have been missed without imaging. One had a small old left middle cerebral artery infarct. The other had a small 1 cm intracerebral hematoma consequent to a recent head injury. In neither was clinical management changed by this knowledge.

Brain imaging confirmed suspected clinical diagnoses in 31 cases. The value of confirmatory results of a diagnostic test is not easily appraised. In an academic atmosphere, such as that in the present study, confirmatory tests have teaching value; such results might have lesser worth in clinical practice.

Another 66 scans showed the mild degree of atrophy seen in many patients with schizophrenia and other psychoses. The meaning of the atrophy in such patients is uncertain; it was always mild.

In 44 cases, findings were incidental and of little or no clinical importance. No diagnosis was made in 192 instances. It is impossible to assess the "rule-out" value of tests. Presumably the large number of normal scans among several indications fulfilled that function.

DISCUSSION

The present survey of 337 brain imaging scans ordered for clinical purposes in psychiatric patients revealed abnormalities in 35% of the cases. Although the most common reason for ordering such scans was to rule out a structural lesion in patients with "functional" psychiatric diagnoses, this indication was least rewarding in discovering abnormalities. A history of neurological disorder or the presence of neurologic/organic mental signs was most predictive of abnormalities; the EEG offered little help, either by itself or combined with clinical findings. As a result of these imaging procedures, four new diagnoses were discovered. Two, both of which were signified by clearly abnormal neurological symptoms and signs, were of major import. Two others were "silent" and were of little apparent clinical consequence.

The frequency with which abnormal brain scans are found in psychiatric patients has been highly variable, ranging from 6.8% to 49.8% (Larsen et al, 1981; Roberts and Lishman 1984). The incidence of 35% in the present study agrees with another report citing 32% abnormalities (Beresford et al 1988). However, so many sources of bias (selection of patients, interpretations of scans, preliminary screening, and

others) are possible that one can not be sure of the normative incidence of such abnormalities.

No previous survey has reported such a high frequency of scans ordered to rule out structural lesions among patients with functional psychiatric diagnoses and with little evidence, either by history or physical examination, of neurological abnormalities. No doubt part of this phenomenon reflects a strong biological bias among members of this department. Yet another factor might be the notion that errors of omission are more serious than errors of commission. Such an attitude can lead to a "heroic search for positive test results" (Woolf and Kamerow 1990). If ordering tests to rule out a diagnosis were tied to some specific diagnosis rather than to an umbrella diagnosis such as "organicity", it is likely that fewer such rule-out tests would be made.

The importance of focal neurologic signs or mental state impairment for predicting abnormal scans has been previously emphasized, although neither sign was sufficiently precise either to rule in or rule out structural pathology (Beresford et al 1988). Focal neurologic signs were also found to be predictive in a survey of 123 patients. All 6 abnormalities that were significant occurred in patients with focal findings on neurological examination (Larsen et al 1981). The most extensive search for predictors of abnormalities in senile dementia examined four that had been suggested in the literature. Two predictors were emphasized as indications for scanning: a) dementia of less than one year duration with headache, focal signs or papilledema; and, b) mild dementia or acute or recent onset of dementia of less than 12 months. Two predictors in which scans were not thought to be useful were: a) dementia or greater than one year duration with gradual onset and no other focal findings; or, b) insidious onset, with duration greater than 3 years and severe. The conclusion of this survey was that none of the predictors was well established (Martin et al 1987).

How often the use of scans affects the diagnosis has been highly variable. In one study, diagnoses were changed in 28 of 165 patients (approximately 17%). Interestingly, the ages of these patients ranged from 31 to 89 with a median age of 60 years (Beresford et al 1988). In the present study, new or unanticipated diagnoses were established in only 4 patients (1.2%). Three of these patients were relatively old (53, 65 and 67 years). Thus, it would appear that the impact of scans on diagnosis is greater for older patients.

Many authors have recommended various indications justifying brain imaging scans (Tsai and Tsuang 1981; Rosenberg et al 1982; Weinberger 1984). In Table 6 data from the present study have been organized according to these various recommendations. Had scans been ordered exclusively for these indications only 185 or 55% of the total number would have been ordered, accounting for only 61% of all abnormal scans. Some of these indications were associated with a fairly high yield of abnormal scans, i.e., presence of focal neurologic signs, mental confusion or cognitive decline, first psychotic break before or after age 50 years, personality change after age 50 years, and history of head trauma. On the other hand, poor indications included the presence of alcohol or substance abuse, seizures, isolated abnormal EEG, and movement disorder. The number of patients with anorexia was too small to draw any conclusion.

Table 6
Results of Brain Imaging Scans on Patients with Recommended Indications for Such Scans

Recommended Indication	Normal N=185	Equivocal N=34	Abnormal N=118	Total N=337
Presence of focal neurologic sign	3	1	9	13
Mental confusion	0	1	4	5
Cognitive decline	2	1	9	12
First psychotic break	1	0	4	5
First psychotic symptom past 50 years	0	0	2	2
Personality change after 50 years	2	0	7	9
Alcohol, substance abuse	24	5	8	37
Head trauma	8	0	14	22
Seizures	33	2	10	45
Abnormal EEG alone	21	3	1	25
Movement disorder	6	1	1	8
Anorexia nervosa	1	0	1	2
	101	**14**	**72**	**185**

On the basis of the present current knowledge, then, one might suggest the following as sound indications for brain imaging: 1) positive history of past head injury, stroke or other neurologic disease as well as suspected Alzheimer disease or multi-infarct dementia; 2) the presence of abnormal neurologic signs or organic mental signs, such as confusion or cognitive decline; or, 3) a first psychotic break or personality change occurring after the age of 50 years. Scanning is not likely to be rewarding for the investigation of mental disorder associated with alcohol or substance abuse, mental disorders without other neuropsychiatric abnormalities, or for the elucidation of seizure disorders or abnormal EEGs.

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